Area 20 Commercial Salmon Fishery By-Catch Monitoring Program, 1994 And 1995

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ABSTRACT

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In 1994 and 1995, a by-catch monitoring program was initiated to determine the impact of the Juan de Fuca commercial sockeye and pink salmon fisheries on non-targeted salmon species. The by-catch monitoring program provided information which aided in reducing the occurrence of incidental catch during the fishery. Estimated incidental catch was compiled in-season and tracked using a yellow line - red line catch ceiling approach. Actions to reduce by-catch were discussed with fishing industry advisors and included voluntary non-retention, reduction in fishing time and a proposed sequence of zone closures. The total annual catch of incidental species during these fisheries was as follows: 1994 (seine and gillnet) - 121,870 coho, 680 chum, 8,769 chinook, 35 steelhead; 1995 (seine only) - 31,061 coho, 1,409 chum, 528 chinook, 8 steelhead.

Monitoring data were collected by examining the catch from seine fishing vessels. Monitoring data consisted of observed numbers of fish (by species) caught in individual sets, date and time of set, and number of sets made up until the observation time. The number of observations recorded for 1994 and 1995 were 242 and 124, respectively.

Post-season analysis of these data included comparisons between in-season and post-season catch estimates, comparison of coho catch among different zones, and estimates of catch variability using Monte Carlo simulations. For the 1994 seine and gillnet fisheries, the difference between the in-season and post-season estimates of total salmon catch was 37,000 (seine) and 151,000 fish (gillnet). For the 1995 seine fishery, the difference between the in-season and post-season estimates of total salmon catch was 76,000 pieces. With respect to coho, the 1994 post-season catch estimate (derived from sales slips) was greater than the in-season catch estimate (derived from observer program) by 1,908 fish (4%). The reverse was true in 1995 when the post-season catch estimate of coho was lower than the in-season estimate by 6,143 fish (16.5%).

Analysis of coho catch per set among the three fishing zones within Area 20 showed no statistical difference at the 0.05 probability level for the year 1995. Results of this analysis using the Kruskal-Wallis non-parametric Anova were $p=0.078$ and $p=0.737$ for 1994 and 1995, respectively. Estimates of catch variability showed considerable range in coho catch estimates derived from the observer program. The 1995 coho catch as estimated by sales slips was 31,061 pieces compared to the observer program estimate of 21,832 (median), with a range of 12,063 - 43,829 (80% probability limits). Review of the monitoring program suggests potential issues in observer coverage, species identification and extrapolation biases. Recommendations for future programs would be dependent on forecast abundance of target species and continued conservation concerns for some non-target salmon species.

Key words: by-catch, salmon, monitoring, Juan de Fuca Strait, commercial fishery.

RÉSUMÉ

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En 1994 et 1995, nous avons lancé un programme de surveillance des prises accessoires pour mesurer l'impact d'une pêche commerciale sur les espèces de saumon non visées par les pêches commerciales du saumon rouge et du saumon rose dans le détroit de Juan de Fuca. Le programme a fourni des données qui ont aidé à réduire les prises accessoires de ces pêches. Le volume estimatif des prises accessoires a été calculé pendant la saison de pêche, et suivi par une méthode avec plafond à limite inférieure et supérieure. Les mesures prises pour réduire les prises accessoires, qui ont fait l'objet de discussions avec les conseillers de l'industrie de la pêche, sont les suivantes : remise à l'eau volontaire, réduction du temps de pêche et proposition d'une série de fermetures de zones. Pendant ces pêches, le volume annuel total des prises accessoires était le suivant : 1994 - 121 870 cohos; 680 kétas; 8 769 quinnats; 35 saumons arc-en-ciel; 1995 (senne seulement) - 31 061 cohos; 1 409 kétas; 528 quinnats; 8 saumons arc-en-ciel.

Les données ont été recueillies par examen des captures des senneurs. Elles relevaient le nombre de poissons observés (par espèce) dans chaque coup de senne, la date et l'heure de l'opération, et le nombre de coups de senne réalisés jusqu'au moment de l'observation. Pour 1994 et 1995, le nombre d'observations consignées était respectivement de 242 et 124.

Pour analyser ces données après la saison, nous avons comparé les captures pendant et après la saison, comparé les prises de coho par zone et estimé la variabilité des prises à l'aide de la simulation Monte Carlo. La comparaison des estimations des prises totales de saumon pendant et après la saison révèle des différences de 37 000 poissons dans les prises à la senne et de 151 000 poissons dans les prises aux filets maillants. En ce qui concerne le programme des observateurs, l'estimation après la saison d'après les bordereaux de vente de coho était supérieure de 1 908 poissons (4 %) aux estimations calculées pendant la saison de 1994 à partir du programme des observateurs. La différence dans les prises totales de saumon entre les estimations faites pendant et après la saison de pêche atteignait 76 000 poissons en 1995 pour la pêche à la senne. Tandis que les prises de coho calculées après la saison à partir des bordereaux de vente étaient plus élevées que les estimations faites pendant la saison en 1994, la situation était inverse en 1995. En 1995, les estimations des prises de coho à la senne faites après la saison totalisaient 31 061 poissons, soit 6 143 (16,5 %) de moins que les estimations fournies par le programme des observateurs pendant la saison.

L'analyse des prises de coho par coup de filet parmi les trois zones de pêche du secteur 20 n'a révélé aucune différence statistique au niveau de probabilité de 0,05. Les résultats de cette analyse de la variance par la méthode non paramétrique de Kruskal-Wallis étaient p=0,078 et p=0,737 respectivement pour 1994 et 1995. Les estimations des captures de coho présentaient une plage considérable de variabilité quand elles étaient faites à partir du programme des observateurs. Les prises de coho de 1995 calculées à partir des bordereaux de vente étaient de 31 061, contre 21 832 (médiane; plage de 12 063 à 43 829, limites de probabilité de 80 %) pour le programme des observateurs. L'examen du programme de

surveillance fait ressortir des problèmes potentiels dans la couverture des observateurs, l'identification des espèces et les biais d'extrapolation. La tenue de tels programmes dans l'avenir dépendrait de l'abondance prévue des espèces cibles, des inquiétudes suscitées par la conservation de certaines espèces et non visées de saumon.

Mots clés: prises accessoires, saumon, surveillance, détroit de Juan de Fuca, pêche commerciale.

1.0 INTRODUCTION

The commercial fishing industry in British Columbia was established in the early 1800s and is currently the fourth largest industry in the province. Of the three main fishery sectors in B.C. (aboriginal, commercial and recreational), the commercial sector presently harvests the majority of salmon. While commercial salmon fisheries are generally planned and directed towards harvesting a single species, this is seldom achieved completely. Current harvesting methods are not one hundred percent effective in selecting between different species as these may exhibit similar characteristics, such as migration routes and timing. Since salmon species differ in their productivity and abundance, a weaker salmon population harvested as a by-catch in a commercial fishery, may be detrimentally impacted. Consequently, the by-catch of non-target species has become a growing concern in the development and implementation of harvest strategies.

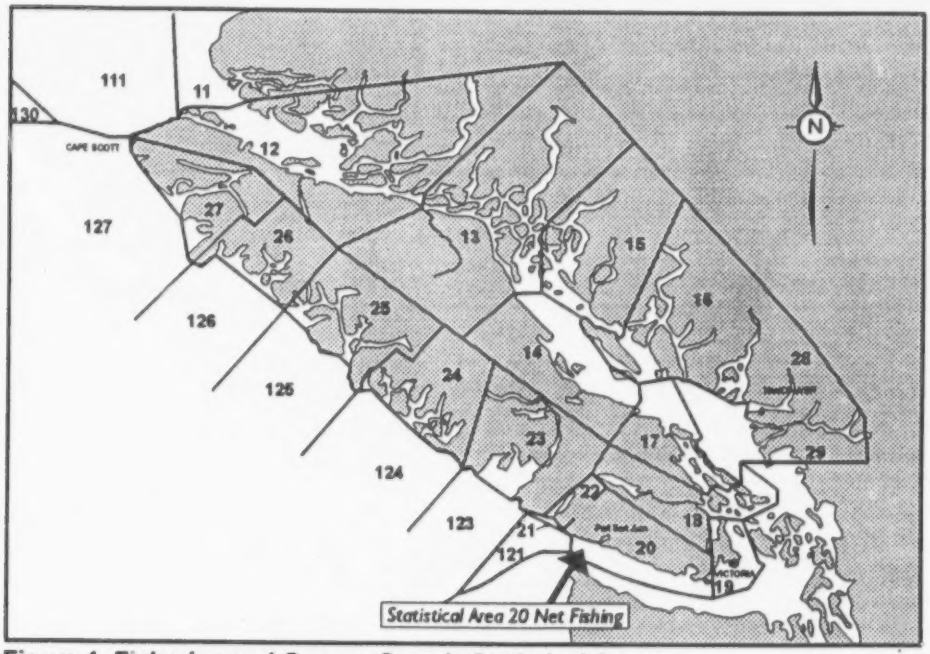

Figure 1. Fisheries and Oceans Canada Statistical Areas.

The 1994 Fraser River sockeye management plan called for an intensive commercial fishery targeting Fraser River sockeye in Juan de Fuca Strait, locally called San Juan (Statistical Area 20, Fig. 1). The expected high level of fishing activity raised concerns over harvesting of non-target species, (particularly chinook, coho and steelhead). In order to document and limit the catches of non-target species, a by-catch monitoring program directed at Area 20 commercial seine and gillnet fisheries was initiated in 1994. The limit for incidental coho catch for 1994 was determined from recent years' (1987-1992) mean annual catch of 161,000 pieces. In addition, a voluntary non-retention of coho, chinook and steelhead was implemented in the seine and gillnet fisheries that year.

In 1995, a by-catch monitoring program similar to the one developed for 1994, was conducted in Area 20. The objective was to reduce the incidental salmon catches, particularly of coho, during the commercial seine and gillnet fisheries directed at Fraser River pink and sockeye salmon. The objective for 1995 was a 10% reduction in the expected Area 20 coho harvest

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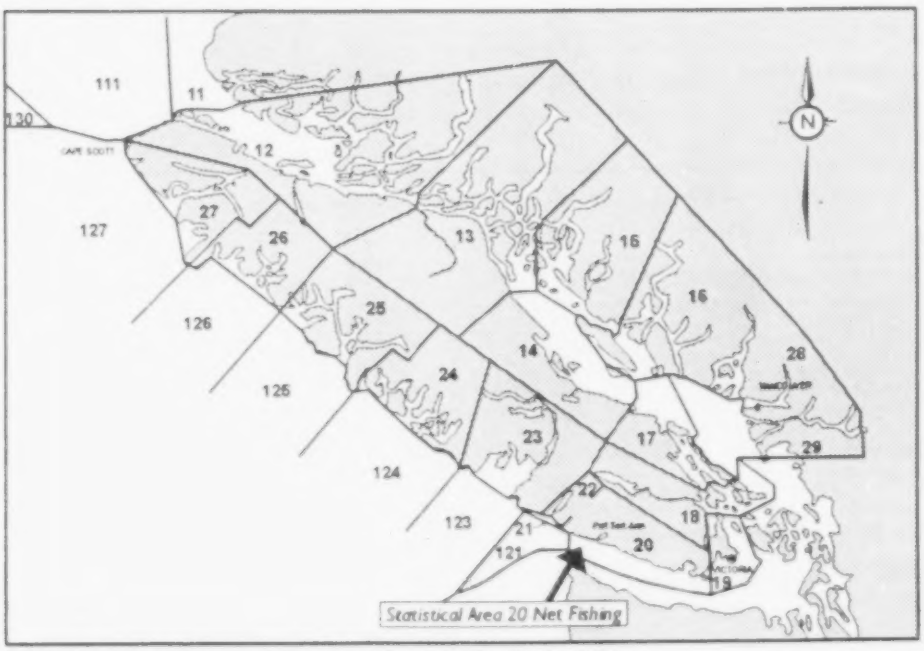

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rate. This "pass through" provision was part of a conservation strategy aimed at reducing the overall exploitation rate of Strait of Georgia coho stocks to below the previously recommended 65-70% level set by the Pacific Stock Assessment Review Committee (PSARC). In addition, mandatory non-retention of chinook and steelhead, and a voluntary release of coho were implemented during the seine fishery in 1995 (gillnet fishery was closed that year).

2.0 AREA 20 (SAN JUAN) BACKGROUND

2.1 Fishing History

Major commercial fishing in Area 20 has been conducted since the mid-1930s (Roos 1991) with the primary target being sockeye and pink salmon returning to the Fraser River. The Area 20 fishery is almost exclusively an interception fishery on non-local stocks, reflecting the relatively low abundance of local salmon populations returning to spawn in this region. Since there are no major commercial fishing communities in the immediate region, all fishing vessels involved in this fishery must travel to this area.

From 1946 to 1985, the Area 20 commercial fishery targeting passing Fraser sockeye and pink salmon stocks has been managed primarily by the International Pacific Salmon Fisheries Commission. With the signing of the Canada/U.S. agreement (Pacific Salmon Treaty) in 1985, this area, along with the rest of the Canadian Panel waters, became the responsibility of the Fraser River Panel (FRP) of the Pacific Salmon Commission (PSC) - a governing body which represents both Canada and the U.S. The FRP generally manages the Panel waters from June to October, while Canada's Department of Fisheries and Oceans (DFO) manages the area for the remainder of the year. In 1992 and 1994 no agreement was reached between Canada and U.S. regarding sharing arrangements on Fraser sockeye and pink salmon. Consequently this fishery and other Canadian fisheries, usually managed by the FRP, were managed by the DFO.

2.2 Historical Catches and Fishing Effort

During the 1977 to 1995 period, the annual commercial salmon catch (all species combined) taken in Area 20 averaged approximately 1,672,000 pieces for seine gear and 279,000 pieces for gillnet gear (Table 1). Sockeye and pink salmon were the primary species targeted by these fisheries, constituting approximately 89% of the total annual net catch in Area 20 (Table 1). Occasionally in the past (e.g., 1987), fisheries have also targeted on coho salmon. This species constituted approximately 166,000 pieces or 9% of the overall salmon catch each year during the 1977-1995 period (Table 1). Historical catch data presented here are derived from recorded catch landings which are part of the sales slip information system.

Table 1. Average annual commercial salmon catch by species in Area 20 by seine and gillnet fisheries, 1977-1995.

	SEINE		GILLNET	
Species	No.	%	No.	%
Sockeye	848,674	50.8	207,527	74.3
Pink	656,952	39.3	22,515	8.1
Coho	129,306	7.7	36,981	13.2
Chum	6,456	0.4	6,098	2.2
Chinook Adult	18,121	1.1	4,632	1.7
Chinook Jack	11,973	0.7	1,500	0.9
Steelhead	246	0	147	0.1
Total	1,671,728	100	279,400	100

Historically, the majority of catch in Area 20 has been harvested by the commercial seine and gillnet fleet which operated weekly during August and early September. During the 1977 to 1995 period, the numbers of fishing vessels operating each year (cumulative total) have averaged 502 seines and 468 gillnets (Table 2). The duration of the fishing season during that period has averaged approximately 10 days for both gear types. The number of fishing vessels operating in Area 20 is based on overflight counts, radar counts and/or records of landing slips from vessels that fished the area.

The duration of the fishery and area boundaries are established prior to fishing. The historical occurrence of this fishery and the migration behavior of the sockeye and pink salmon have produced a "line type fishery".

Table 2. Annual gear count and days open in Area 20 seine and gillnet fisheries, 1977-1995.

	GEAR COUNT		DAYS OPEN*	
Year	Seine	Gillnet	Seine	Gillnet
1977	937	1,126	14	14
1978	320	595	8	8
1979	901	426	12	12
1980	334	642	10	10
1981	538	401	15	15
1982	541	578	8	8
1983	46	3	3	3
1984	307	221	11	11
1985	941	536	13	13
1986	636	723	8	8
1987	442	238	6	6
1988	405	353	6	4
1989	949	820	16	22
1990	518	403	7	10
1991	414	945	6	11
1992	219	240	19	21
1993	177	231	2	5
1994	283	403	12	16
1995	627	0	5	0
Avg. 77-95	502	468	9.5	10.4

*12 hours = 1 day open for fishing

2.3 Fishing Boundaries

The seine fishery in Area 20 is referred to as a "Blue Line" fishery. This consists of vessels operating along fishing lines perpendicular to the shore, with fishing location dependent on ocean depth and operating distance between fishing vessels. The vessels along the fishing line are separated from each other according to depth contours (every 5-10 fathoms) starting at the innermost boundary and continuing southerly. Seine fishers position their vessels approximately one-half nautical mile apart along these fishing lines, and compete for the best position, closest to the "Blue Line". Several seine vessels will queue or "wait for their turn" to make a set in a particularly good area. The current boundaries for the Area 20 fishery extend from the western border of Statistical Area 20 ("Blue Line") to Sheringham Point (Fig. 2) and encompass the DFO's Statistical Areas 20-1, 20-3, 20-4.

In the past, boundaries have been adjusted for the conservation of non-target stocks. The adjustments included a contour boundary of 30 fathoms to the shoreline in Area 20-1 (introduced in 1989 for the conservation of chinook) and on one occasion, moving the outer westerly boundary (Blue Line) to a more easterly location.

The fishing boundaries set for 1994 and 1995 were identical. However, as a result of discussions with fishing industry advisors from the Fishing Vessel Owners' Association (FVOA) and members of the United Fishermen and Allied Workers (UFAW) seine fishermen, two potential boundary adjustments were proposed for 1995. The first potential modification

involved closing the southwest corner of the area, outside the 100 fathom contour to 3 miles east along the Canada/U.S. border (zone A, Fig. 2).

The second potential adjustment was placing an outside ribbon boundary along the 100 fathom contour to the Canada/US border (zone B, Fig. 2). The adjustments were designed to reduce the coho by-catch during the commercial sockeye and pink fishery.

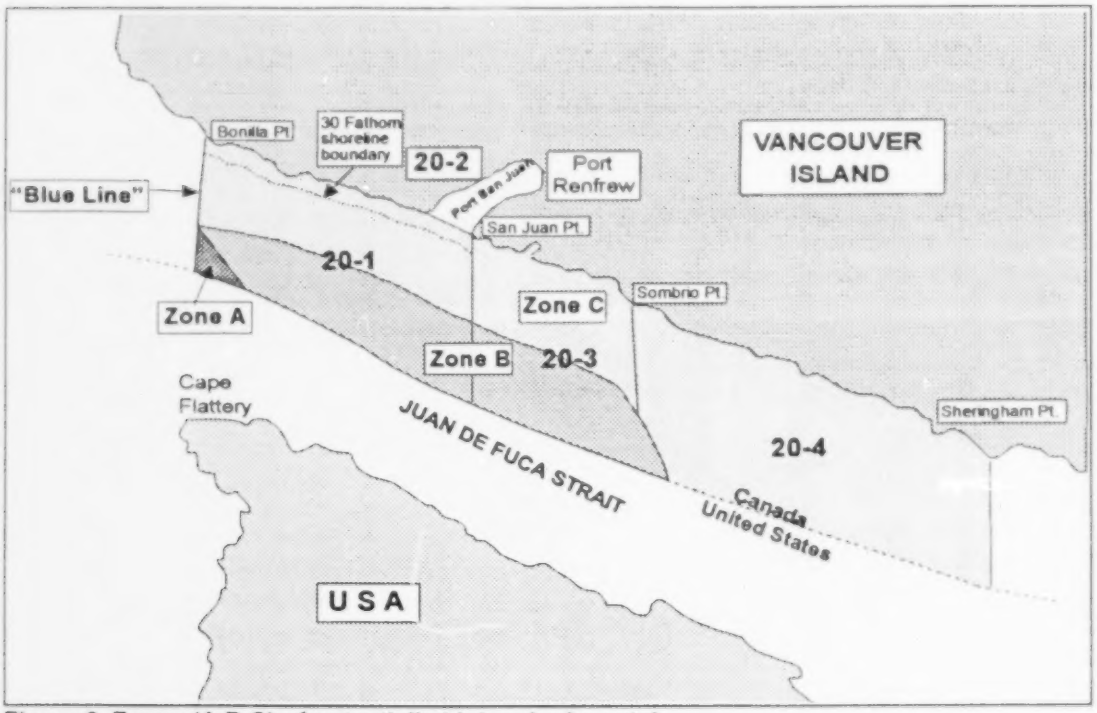

Figure 2. Zones (A,B,C) of potentially high coho by-catch.

2.4 Management Actions

Historically, management actions for the Area 20 fishery have been directed at the target species - Fraser River pink and sockeye salmon. Recently, increased attention has been focused on the incidental catches of non-target salmon species. With many harvesting groups becoming more efficient, the conservation strategy aims at ensuring that those stocks and species requiring conservation may receive "protection" along their entire migratory route to the spawning grounds.

Management actions focusing on reducing the mortality of non-target salmon species (chinook, coho and steelhead) include the implementation of voluntary beach / ribbon type boundaries, voluntary and mandatory releases, delayed scheduled openings and early fishery closures. Strategies for area closures were developed for 1995 but were not implemented that year because coho by-catch remained low.

For the Area 20 gillnet fishery, strategies applied in the past to reduce incidental catch, have included the non-retention of fish, whenever possible. In 1994, the ratio of potential by-catch to

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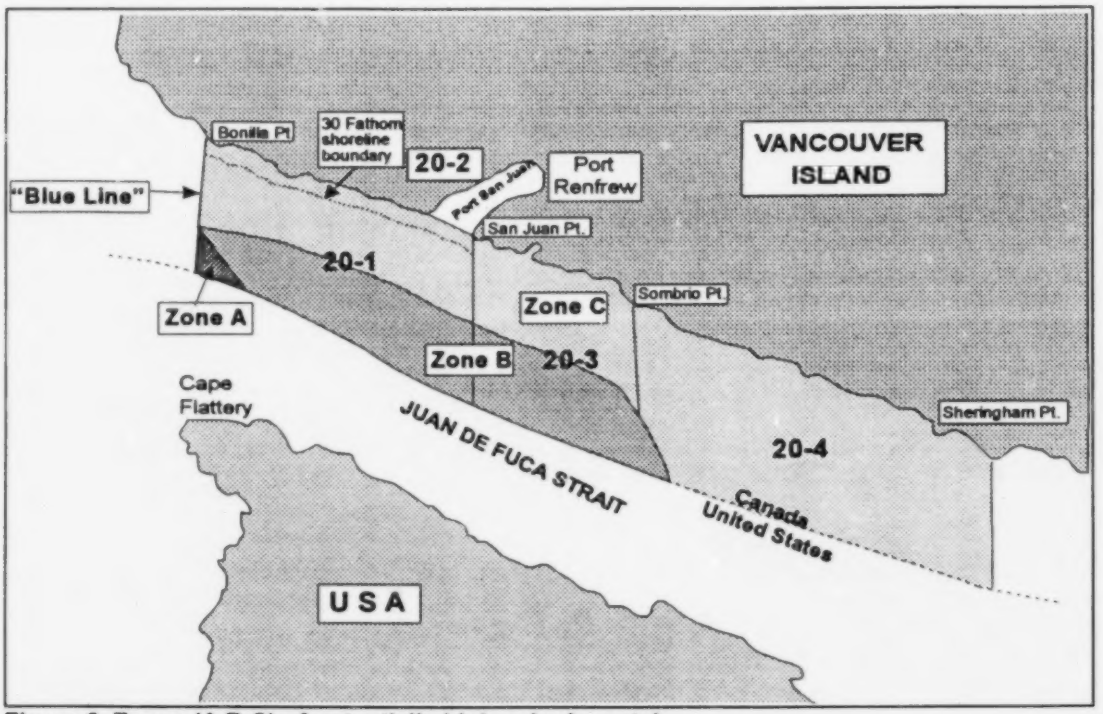

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target-species catch and the availability of alternative fishing locations resulted in the gillnet fishery closure late in the season. For 1995, the two suggested strategies to reduce by-catch in the gillnet fishery were to fish only during daylight hours when targeting on sockeye and modifications to the fishing area. These strategies were not required as no commercial gillnet fishing occurred in 1995.

2.5 Volunteers

A volunteer program was undertaken in both 1994 and 1995, with volunteer observers arranged through the Recreational Fisheries Unit of the DFO. The volunteers were generally transported to the DFO patrol vessel prior to the fishery, then to the monitoring boat or directly to the fishing vessel where catch information was collected. The volunteers frequently remained for several hours onboard the fishing vessel to observe fishing activity, then were transported either back to the patrol vessel or to the landing port (Port Renfrew). Volunteer observers came from several concerned groups, such as the B.C. Wildlife Federation and Greenpeace.

3.0 BY-CATCH MONITORING PROGRAM, 1994 AND 1995

The by-catch monitoring program provided additional information required to adjust boundaries during the fishery, based on the observed coho catch by area.

The by-catch monitoring program was similar for 1994 and 1995, and consisted of three main parts: 1) monitoring, 2) strategies for reducing the by-catch and 3) implementation of strategies.

3.1 Monitoring and Catch Estimation

Information was collected directly on the fishing vessel by examining the catch as it was landed. Information on sample forms was delivered to the Fisheries vessel by radio or in person. Data were generally compiled after the fishing day was complete in 1994 and during the fishing day in 1995. The change in data compilation timing in 1995 allowed for a faster response to modifying the fishing plan if by-catch rates were higher than acceptable. Catch rates (average number of fish caught per set by species) were then calculated. Estimates of total catch of non-target species for that day were based on the remaining projected fishing time and the number of vessels operating in the area. In addition, catch rates by zone (observed catch x vessels x remaining time to close of fishery) were assessed to determine if there was a geographical difference in the catch rate within the existing boundary lines.

The monitoring program in both years was directed exclusively at the seine fishery. Two high speed inflatable rafts, each with two professional observers and a driver, were used. The driver would drop observers on separate vessels usually at the end of a tow. Monitoring generally began near the western border (Blue Line) of Area 20-1, where observers would board seine vessels, subsequently working their way down to Jordan River in Statistical Area 20-4. The procedure involved approaching the vessel, requesting permission to board, staying aboard for one set, recording information, then moving to the next vessel. On several occasions, representatives of interested and concerned groups accompanied the observers to examine the program.

Information recorded by the professional observers included (Nagtegaal et al. 1993):

- catch per set by species
- number of sets per vessel per day
- number of vessels fishing

Data were stratified by day and collected daily during the operation of the 1994 and 1995 sockeye and pink salmon fisheries. No stratification was made by zone. Monte Carlo simulations were conducted within strata (day) and then summed to estimate total catch and the resultant catch distribution.

Catch per Set

Two crews (two observers and a boat operator per crew) were tasked with providing onboard observations of catch per set. Seine vessels were randomly selected for boarding in order to observe the catch per set. Observers would keep track of all salmon species. In case of chinook, observers would also record whether the fish were adult or jack. Adult chinook were those fish greater than about 5 pounds (2.27 kg) while all smaller chinook were considered jack. Observers were also required to record whether chinook, coho and steelhead were landed or released. The fishing plan for Area 20 called for a voluntary release of chinook and steelhead in 1994 and a mandatory release of both species in 1995. Observers would stand by the seine drum and record all fish as they were brought onto the vessel (it was difficult to observe all species when large catches were made). Observers also collected information on catch location, time, and depth.

Number of Sets per Vessel Day

Information concerning the number of sets per vessel per day was collected by observers by asking the seine vessel skipper how many sets were made up to that time period. These estimates were then extrapolated to cover the total fishing period (expansion method). If a fishery extended over two consecutive days or longer, the observer would also ask how many sets were made the previous day (consecutive day method).

Number of Vessels Fishing

Gear counts were made each day of the fishery using a combination of radar and visual estimates. The visual gear count estimates were provided by Fisheries patrol personnel while the radar estimates were obtained from the Fisheries patrol vessel. These were then compared with the actual number of vessels making landings, and the gear counts obtained by Pacific Salmon Commission staff.

Location of Sets - Latitude/Longitude

Location of the sets was recorded by an observer onboard the fishing vessel using either electronic plotters or Loran C bearings. Vessel position was also taken directly from a chart or recorded as time differences (T.D.s - a five-digit number which can be converted back into latitude and longitude). The bearings used for analysis were those taken from a plotter, Loran C or a nautical chart.

Catch Estimation and Monte-Carlo Simulations

Catch for each stratum was calculated as:

$$T_i = \sum_{j=1}^{n} (C_{ij} \times S_j \times V_j)$$

Where:

T_i is the total catch estimate for species *i* over the total season

C_{ij} is the catch per set for species *i* during fishing day j

S_j is the number of sets/day/vessel during the fishing day *j*

$_j$ is the total number of fishing vessels during the fishing day *j*

n is the number of days of fishing.

3.2 Strategy Implementation

The main strategy for tracking coho by-catch in Area 20 was designated as the "yellow line - red line" approach. This generally involves monitoring cumulative catch during the fishery and comparing this to an established range of cumulative projected catch. For example:

- If the projected catch is below the projected lower range catch, no regulatory action is required.
- If the projected catch exceeds the projected lower range (yellow line), some conservation action is required to reduce the actual catch to below the lower range.
- If the projected catch continues to increase above the lower catch range towards the projected upper catch range (red line), additional regulatory actions are required.

A similar type of strategy (green line - red line) has be used in other fisheries, for example the West Coast Vancouver Island troll fishery. The major difference in this strategy is that the target or ceiling is the desired goal, and catches below the green line are accelerated by management actions. In the yellow line - red line approach, the ceiling is not a goal (the desired goal is below the ceiling) and all management actions are imposed to reduce catches.

Several other strategies or regulatory actions were used in Area 20 to reduce coho by-catch and mortality throughout the fishing season: release or non-retention of coho, boundary modification during the fishery, and closure of the fishery.

Non-Retention Fisheries

The catch and release strategy is directed primarily at seine fisheries. This appears to be a viable conservation measure if the seine set is small, resulting in relatively high expected survival (70-75%) of released coho (R. Kadowaki, pers. comm.) Candy et al. (1996) showed an overall survival of 77% in seine released chinook salmon, with survival increasing as the landing time decreased. However, if the fish volume per set is large, the practicality of this not-

retention strategy and the survival of released fish may be reduced. This is because in a large set, the identification of coho becomes difficult, and the handling of large numbers of fish without damage becomes a problem.

The catch-and-release strategy was implemented throughout the fishing season, thereby reducing the risk of reaching a red-line stage which would lead to a fishery closure. The above baseline action would be taken in addition to other actions that would apply to the yellow line - red line approach.

Boundary Modification During Fishery

One of the strategies to reduce coho by-catch while providing adequate opportunity to fish the target species is to assess areas of high coho by-catch during the fishery and close those zones. The information collected from the monitoring program during the fishery assisted managers in deciding which zones should remain open. Coho catch rates were collected throughout the fishery and reviewed by the DFO and fishermen for possible zone closures.

Closure of Fishery

To assist in determining closure and subsequent fishery reopening, several factors were reviewed. These included: PSC seine and gillnet test fishing data, in-season run size estimates for target species, timing and catch compositions, and previous fishery catches. In consultation with fishermen, a strategy was adopted whereby the duration of a fishery opening would be scheduled for one 12-hour period only. This single opening would allow daily catches to be reviewed in order to evaluate possible further fishing during the current fishing period. The ratio of coho to target-species catch was also reviewed, and possible closure of the gillnet or seine fishery was based on a comparison with the historical ratios. The coho to target-species catch ratio generally increases later in the season (September) as target catch abundance declines and coho abundance increases.

3.3 1994 Details

In 1994, the management objective for coho catch in Area 20 was based on the average annual coho by-catch for the period 1987 to 1992. The total annual fishing days for that period ranged between 6 and 19 days for the seine fishery and between 6 and 22 days for the gillnet fishery (Table 2) (the year 1993 was not used as very little commercial fishing on sockeye occurred that year). For the above time period, the cumulative catch of coho in Area 20 for the combined seine and gillnet fisheries averaged 161,000 pieces annually.

Based on this value and the average catch of coho by week (1987-1992 data), the yellow line - red line approach was developed for the Area 20 fisheries in 1994 (Fig. 3).

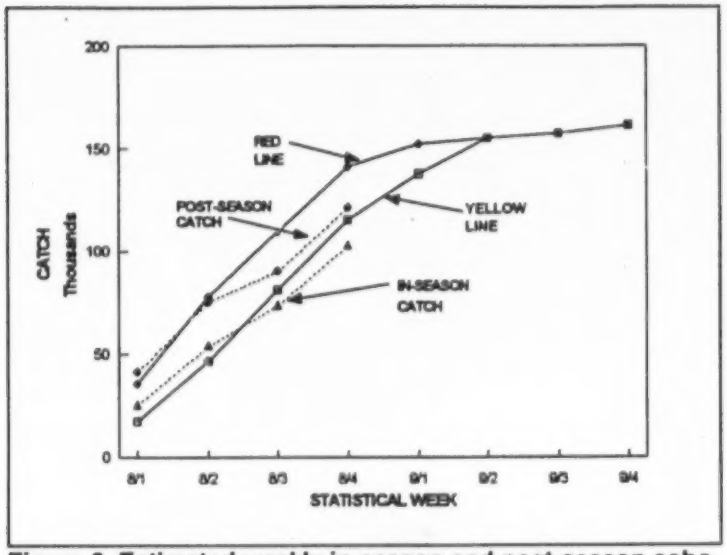

Figure 3. Estimated weekly in-season and post-season coho catches in Area 20 compared to upper and lower catch ceilings, 1994.

Management actions for the 1994 season included the following:

- Voluntary release of chinook, coho and steelhead during the commercial seine and gillnet fisheries.
- No fishing shoreward of the 30 fathom contour, a voluntary compliance in effect for Area 20-1. This action was directed at reducing chinook interceptions.
- Seine net restriction of a minimum bunt mesh-size of 100 mm. This assisted in allowing smaller fish to escape capture.

In 1994, a total of 404 seine vessels were recorded fishing in the 12 days open to seine fishing (Table 3). Observers made a total of 242 boardings on 118 different seine vessels during the openings. A total of 403 gillnet vessels fished during the 16 days open to gillnet fishing that year. During the latter part of the 1994 season, the seine and gillnet fisheries were delayed and re-scheduled due to a low target catch of sockeye salmon and a high by-catch of coho.

3.4 1995 Details

The yellow line - red line approach was instituted again in 1995; however, separate seine and gillnet catch ceilings for coho were established that year. The catch ceiling for seines ranged between 129,000 and 164,000 coho, and for gillnets between 28,000 and 36,000 coho. This resulted in an overall pre-season catch ceiling range of 157,000 to 200,000 (average 179,000), based on projected coho abundance estimates.

Due to the absence of early fisheries, the catch ceiling was lowered in-season to an upper and lower range of 150,000 and 121,000 coho (Fig. 4).

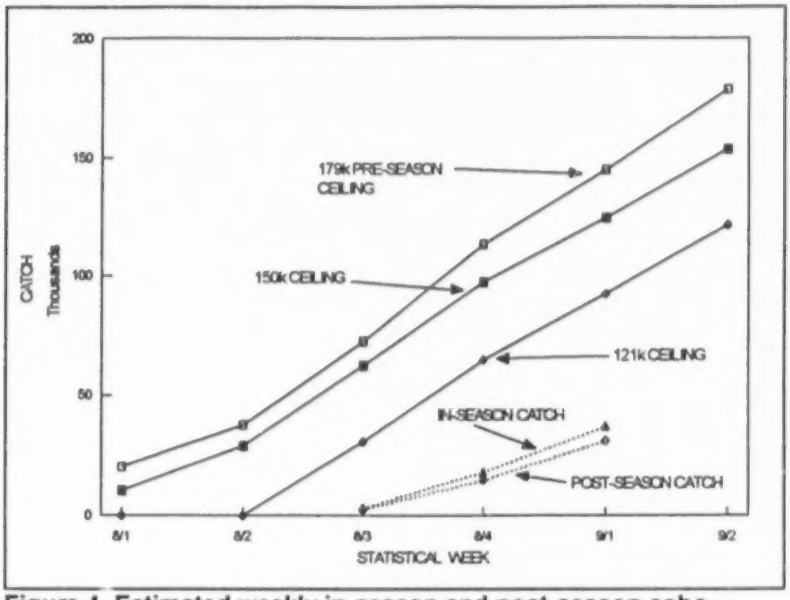

Figure 4. Estimated weekly in-season and post-season coho catches in Area 20 compared to upper and lower catch ceilings, 1995.

Although the yellow line - red line approach suggests that regulatory actions may not be necessary until the coho catch reaches the yellow line, this approach was modified for 1995. It was agreed, in consultation with Industry Advisors, that specific actions would be taken in 1995 throughout the Area 20 fisheries in an attempt to ensure that coho catch remained below the acceptable level. These measures, along with other more restrictive actions, are listed below.

Actions during the 1995 commercial fishery in Area 20 included the following:

- Mandatory release and non-retention of chinook and steelhead, and a voluntary release of coho in the seine fishery.
- A 30 fathom contour boundary for sub-Area 20-1 (voluntary compliance) (Fig. 2).
- Seine net restriction of a minimum bunt mesh-size of 100 mm.
- Early closure of the seine fishery, based on catch data and advice from commercial fishing Advisors.
- Total closure of the gillnet fishery due to the potentially high by-catch of non-target species.

In 1995, two regions or zones in Area 20 were identified by Industry Advisors as having potentially high coho by-catch: the southwest corner of the open fishing area and the area outside the 80 fathom contour (Fig. 2). These regions were assessed during the fishery in the by-catch monitoring program, and announcements made of possible closures to these zones. The announcements would be made at 4 and 8 hours into the fishery. The review of a possible closure was discussed with Advisors. Note that as in past years, the 30 fathom shoreline boundary (Fig. 2) would remain in effect throughout the fishing season. This shoreline boundary is primarily for the conservation of chinook; the effect of this boundary on coho is unknown. In 1995, 642 seine vessels were recorded in 5 openings. Observers made 124 boardings on 72 different seine vessels during the openings.

4.0 RESULTS OF THE MONITORING PROGRAM

4.1 1994 Monitoring Data

The 1994 monitoring program was conducted during August 7-21, for a total of 242 observations involving 118 different vessels. Of the 12 days of seine fishing, 7 were monitored (the first 2 days were not monitored due to program start-up delays and 3 additional days were not monitored due to the small size of commercial fleet operating in that period - fewer than 11 vessels).

The 1994 catch monitoring data are summarized in two categories (Table 3): A) the observed numbers of fish landed and released by sampling day and number of sets made; B) the expanded estimated numbers of fish landed and released by sampling day and total gear operating. For example, over the total sampling period, 1,087 coho were observed as retained, and 68 as released, giving an expanded estimate of 13,516 coho retained as catch and 1,132 released.

Table 3. Summary of by-catch monitoring data for Area 20 seine fishery, 1994.

A) Observed Fish Landed and Released by Sampling Day, and Number of Sets Made

		CHINOOK ADULT		CHINOOK JACK		COHO		STEELHEAD		SOCKEYE	Sets Prior to	Sets Recorded	Number of Sets
DATE	Week	Retain	Release	Retain	Release	Retain	Release	Retain	Release	Retain	Observed	Day Prior	Sampled
07-Aug	8/2	27	13	36	11	21	1	1	1	2,958	150	398	30
08-Aug	8/2	39	11	32	16	14	0	0	1	5,835	239	277	62
10-Aug	8/2	54	23	40	34	380	30	0	3	3,608	286	246	75
11-Aug	8/2	38	31	34	17	231	35	0	15	1,352	160	70	42
14-Aug	8/3	10	1	47	6	245	1	0	0	657	50	81	14
15-Aug	8/3	1	0	28	1	116	1	0	0	290	11	38	8
21-Aug	8/4	11	0	8	13	80	0	0	1	77	26		11
TOTAL		180	79	225	98	1,087	68	1	21	14,777	922	1,110	242

B) Estimated Catch and Release by Sampling Day, Average Sets per Day and Gear Count

		CHINOOK ADULT		CHINOOK JACK		COHO		STEELHEAD		SOCKEYE	Average Sets	Gear	Percent of Sets
DATE	Week	Retain	Release	Retain	Release	Retain	Release	Retain	Release	Retain	per Day	Count	Sampled
07-Aug	8/2	765	368	1,020	312	595	28	28	28	83,847	10.7	82	3.4%
08-Aug	8/2	502	142	412	206	180	0	0	13	75,095	9.7	82	7.8%
10-Aug	8/2	644	274	477	405	4,530	358	0	36	43,589	8.7	103	8.4%
11-Aug	8/2	794	648	710	355	4,827	731	0	313	28,252	7.9	111	4.8%
14-Aug	8/3	56	6	263	34	1,369	6	0	0	3,670	11.2	7	17.9%
15-Aug	8/3	9	0	251	9	1,039	9	0	0	2,596	10.2	7	11.2%
21-Aug	8/4	134	0	98	159	977	0	0	12	940	11.2	12	8.2%
TOTAL		2,904	1,438	3,230	1,479	13,516	1,132	28	403	237,990	9.9	404	6.5%

4.2 1995 Monitoring Data

In 1995, monitoring in Area 20 was initiated on August 22, on the first opening of the commercial seine fishery (Table 4). A total of 124 observations involving 72 different vessels, were made during 1995. Commercial fisheries occurred on August 22, 28 and 29 and on September 5 and 6. Monitoring occurred during each fishery.

Table 4. Summary of by-catch monitoring data for Area 20 seine fishery, 1995.

A) Observed of fish landed and released by sampling day and number of sets made.

		CHINOOK ADULT		CHINOOK JACK		COHO		STEELHEAD		SOCKEYE	PINK	Sets Prior to	Sets Recorded	Number of Sets
Date	Week	Retain	Release	Retain	Release	Retain	Release	Retain	Release	Retain	Retain	Observed	Day Prior	Sampled
22-Aug	8/3	5	14	3	1	17	24	0	1	411	2,294	79	0	22
28-Aug	8/4	16	16	5	4	47	85	0	0	802	2,418	165	0	33
29-Aug	8/4	3	8	5	9	72	83	0	0	609	3,541	76	127	21
05-Sep	9/1	3	3	2	1	427	486	0	4	88	5,653	190	0	38
06-Sep	9/1	0	3	0	2	102	68	0	1	31	898	29	78	10
Total		27	44	15	17	665	746	0	6	1,941	14,804	539	205	124

B) Estimated Catch, Release and Gear Count

		CHINOOK ADULT		CHINOOK JACK		COHO		STEELHEAD		SOCKEYE	PINK	Average Sets	Gear	Percent of Sets
Date	Week	Retain	Release	Retain	Release	Retain	Release	Retain	Release	Retain	Retain	per Day	Count	Sampled
22-Aug	8/3	241	674	144	48	1,473	1,156	0	48	19,790	110,460	10.28	103	2.1%
28-Aug	8/4	579	579	181	145	2,337	3,075	0	0	29,013	87,473	8.47	141	2.8%
29-Aug	8/4	141	375	235	422	4,644	3,895	0	0	28,582	166,191	7.47	132	2.1%
05-Sep	9/1	81	81	54	27	20,825	13,168	0	108	2,384	153,167	7.80	132	3.7%
06-Sep	9/1	0	157	0	105	9,595	3,554	0	52	1,620	46,929	3.90	134	1.9%
Total		1,042	1,866	614	747	38,874	24,848	0	209	81,390	564,220	38	642	2.6%

Calculations were similar to those used for the 1994 season. The 1995 in-season coho monitoring results were adjusted to correct for differences in the in-season observed and final coho catch estimates. The adjustment factor included differences between the 1994 in-season and final sales slip data and weekly 1995 data, as it became available during the season.

4.3 Catch Estimation

Estimation of catch during the season (i.e., in-season estimates) depends on several significant factors, such as, number of vessels operating and number sampled, average catch per vessel, precision of species identification, and volume of catch per set. The accuracy of these data determines the accuracy of the catch estimates. The estimated weekly (in-season) catches by species for 1994 are shown for seine and gillnet fisheries in Table 5.

Table 5. Weekly in-season catch estimates by species in Area 20 seine and gillnet fisheries, 1994.

SEINE							
Week	SOCKEYE	COHO	PINK	CHUM	CHINOOK ADULT	CHINOOK JACK	STEELHEAD
8/1	163,077	12,008	126	29	542	0	0
8/2	242,000	13,441	0	0	3,469	3,258	0
8/3	17,514	10,260	8	35	210	210	0
8/4	2,147	12,114	0	71	60	105	0
Total	424,738	47,823	134	135	4,281	3,573	0
GILLNET							
Week	SOCKEYE	COHO	PINK	CHUM	CHINOOK ADULT	CHINOOK JACK	STEELHEAD
8/1	173,880	13,420	0	0	1,150	0	0
8/2	70,266	15,125	2	422	769	776	0
8/3	12,985	9,371	0	7	179	182	0
8/4	3,677	16,883	0	25	85	53	0
Total	260,808	54,799	2	454	2,183	1,011	0

Table 6 shows similar data for the 1995 seine fishery. (Note that no gillnet fishing occurred in 1995). The estimated catches of incidental species were derived primarily from the monitoring program, while the catches of target species (sockeye and pink) were calculated from a combination of hail and monitoring data.

Table 6. Weekly in-season catch estimates by species in Area 20 seine fishery, 1995.

Week	SOCKEYE	COHO	PINK	CHUM	CHINOOK ADULT	CHINOOK JACK	STEELHEAD
8/3	18,359	3,080	115,650	133	113	366	15
8/4	47,450	14,882	457,470	291	183	1,372	27
9/1	2,681	19,242	283,500	900	20	333	6
Total	68,490	37,204	856,620	1,324	316	2,071	48

The post-season catch estimates for Area 20, based on sales slip data, are shown for 1994 and 1995 in Tables 7 and 8, respectively. Test fishing catches have been subtracted from the sales slip database resulting in only commercial catch estimates shown in Tables 7 and 8.

Table 7. Weekly post-season catch estimates by species for Area 20 net fisheries, 1994.

SEINE							
Week	SOCKEYE	COHO	PINK	CHUM	CHINOOK ADULT	CHINOOK JACK	STEELHEAD
8/1	144,587	14,643	1,189	57	731	1,194	3
8/2	263,686	18,471	1,061	392	4,601	1,328	2
8/3	43,677	5,547	78	38	174	450	0
8/4	3,500	11,070	1	48	51	101	2
Total	455,450	49,731	2,329	535	5,557	3,073	7
GILLNET							
Week	SOCKEYE	COHO	PINK	CHUM	CHINOOK ADULT	CHINOOK JACK	STEELHEAD
8/1	242,303	26,733	104	51	1,459	898	7
8/2	118,260	15,559	41	51	1,297	441	18
8/3	24,238	9,291	4	16	306	271	3
8/4	7,032	20,556	2	27	150	126	0
Total	391,833	72,139	151	145	3,212	1,736	28

Table 8. Weekly post-season catch estimates by species for Area 20 seine fishery, 1995.

Week	SOCKEYE	COHO	PINK	CHUM	CHINOOK ADULT	CHINOOK JACK	STEELHEAD
8/3	17,198	2,629	120,365	302	244	156	5
8/4	41,177	11,966	437,846	345	208	156	3
9/1	2,566	16,466	237,770	762	76	69	0
Total	60,941	31,061	795,981	1,409	528	381	8

Management of the fishery relies primarily on catch information derived during the season (in-season catch). Official DFO catch statistics are compiled after the season using the sales slip

data. The two catch estimates for each of 1994 and 1995 are compared in Tables 9 and 10, respectively.

Table 9. Comparison of annual catch between in-season and post-season estimates, 1994.

	SEINE			GILLNET		
Species	In-Season	Post-Season	Difference *	In-Season	Post-Season	Difference*
Sockeye	424,738	455,450	30,712	260,808	391,833	131,025
Coho	47,823	49,731	1,908	54,799	72,139	17,340
Pink	134	2,329	2,195	2	151	149
Chum	135	535	400	454	145	(309)
Chinook Adult	4,281	5,557	1,276	2,183	3,212	1,029
Chinook Jack	3,573	3,073	(500)	1,011	1,736	725
Steelhead	0	7	7	0	28	28
Total	480,684	516,682	36,998	319,257	469,244	150,605

Table 10. Comparison of annual catch between in-season and post-season estimates, 1995.

	SEINE		
Species	In-Season	Post-Season	Difference*
Sockeye	68,490	60,941	(7,549)
Coho	37,204	31,061	(6,143)
Pink	856,620	795,981	(60,639)
Chum	1,324	1,409	85
Chinook Adult	316	528	212
Chinook Jack	2,071	381	(1,690)
Steelhead	48	8	(40)
Total	966,073	890,309	76,358

4.4 Zone Analysis

The coho by-catch (both retained and released coho) was compared for differences among the three zones (A, B and C, Fig. 2) within a year. The analysis of variance for 1994 suggested a possible difference among the three zones in coho catch/set (p=0.078), with coho catch/set higher in zone A (Table 11). However, the results from 1995 showed no significant difference among the three zones (p=0.737). The results from analysis of the other salmon species also showed no significant differences.

Table 11. Average species catch per seine set by zone and analysis of variance on coho catch per set among three zones within Area 20 seine fishery, 1994 and 1995.

1994							
	(N)	SOCKEYE	PINK	COHO	CHINOOK ADULT	CHINOOK JACK	STEELHEAD
Zone A	15	39.67	N/A	9.8	1.07	0.73	0.07
Zone B	13	55.15	N/A	3.31	0.85	1.15	0
Zone C	215	62.92	N/A	4.49	1.08	1.38	0.1
ANOVA - coho 1994: Probability Level = 0.078							
1995							
	(N)	SOCKEYE	PINK	COHO	CHINOOK ADULT	CHINOOK JACK	STEELHEAD
Zone A	7	4	109.29	15.43	0.14	0	0
Zone B	10	10.9	148.8	16.4	0.2	0.1	0.1
Zone C	107	16.86	117.3	10.64	0.64	0.29	0.05
ANOVA - coho 1995: Probability Level = 0.737							

(N) = sample size

4.5 Monte Carlo Simulations

The Monte Carlo simulations provide an estimate of the variation (minimum, maximum, and standard deviations) about the catch estimates. The calculated catch estimates from the Monte Carlo simulations were compared to the sale slip estimates. The simulations were constructed only for the 1995 data since in 1994 only 7 of the 12 fishing days were sampled.

First, however, a post-season evaluation of the 1995 data set was conducted. This evaluation examined the estimated average number of sets/day/vessel and the underlying distribution of the two variables - catch/set and sets/day.

During the 1995 fishery in Area 20, a total of 124 seine vessel boardings were made to gather salmon catch information. Catch per set recorded for each salmon species, was highly skewed (Fig. 5). Steelhead showed the lowest catch rate (range 0-1) per set, with 95% of the sets reporting no steelhead. Of the 6 steelhead observed captured during the 1995 fishing season, all were released. Catch/set for chinook adults ranged from 0 to 7 and for juveniles from 0 to 2. Of the 124 sets monitored by observers in 1995, 86% and 82% of the sets showed zero adult and zero juvenile chinook, respectively. The catch/set distributions for coho and sockeye were quite similar, although only 61% of the captured coho were retained. Pink salmon showed the broadest catch/set distribution (range 0 to ~1,500).

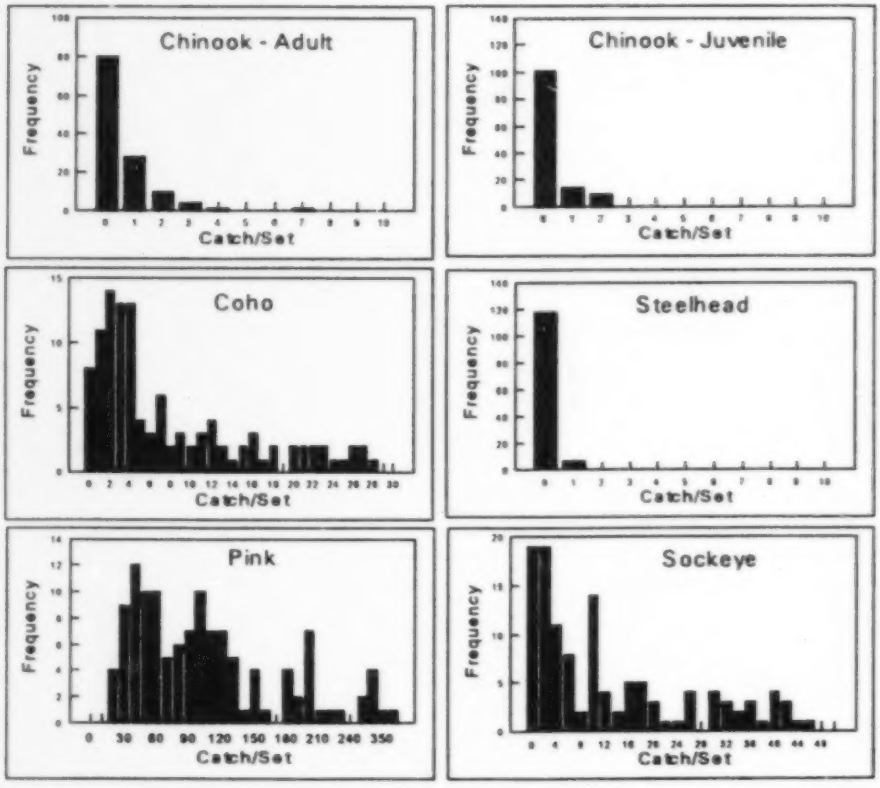

Figure 5. Frequency of salmon catch (retained and released) per set in Area 20 seine fishery, 1995.

The Monte Carlo simulations were conducted with error about the average number of sets/day and catch/set. Examination of the distribution plots led us to believe that both distributions were log-normally distributed (Fig. 5). No error was assumed about the gear count each day as we had no estimate upon which to base the magnitude of the error. Therefore, our estimates of the confidence limits are probably too small.

The number of sets/day, calculated by the expansion method, ranged from a low of 4/day to a high of about 21/day (Fig. 6). Fishing periods were generally 12 hours in duration (0600 h to 1800 h), except on September 6,1995 when the fishery closed at 1400 h rather than at the scheduled 1800 h. No stratification was made of the data sets according to the location of fishing vessel, although the number of sets made per day would probably be lower at the Blue Line where longer vessel line-ups occurred than further east on the second or third lines. However, since the total number of seine vessels operating in Area 20 in 1995 was low (103-141), the majority of the fishing vessels were in the vicinity of the Blue Line.

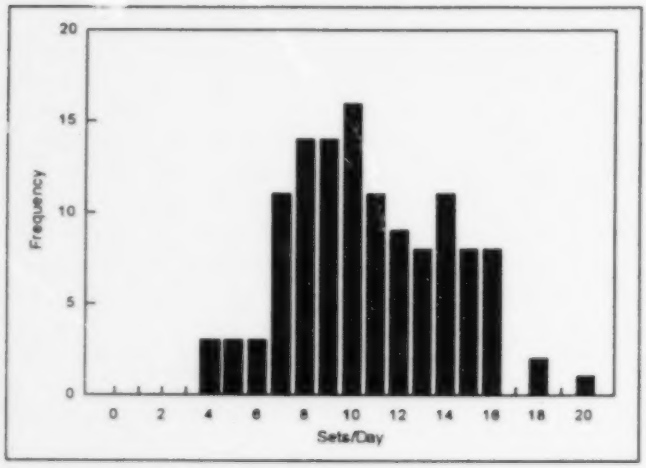

Figure 6. Daily frequency of sets per day in Area 20 seine fishery, 1995.

When the data were examined by time of interview it became apparent that the earlier interviews showed the highest number of sets/hr (Fig. 7). The reason for this is because at the beginning of the fishing day, the observers were interviewing those boats actually fishing and not those waiting in line for their turn to set. As the day progressed, various periods of waiting and/or equipment problems have occurred and therefore the estimated number of sets/hr decreased. About 8 hours into the fishery, the decrease in the number of sets/hr started to level off and by that time, only a relatively small expansion of the data to the end of the day's fishing was required.

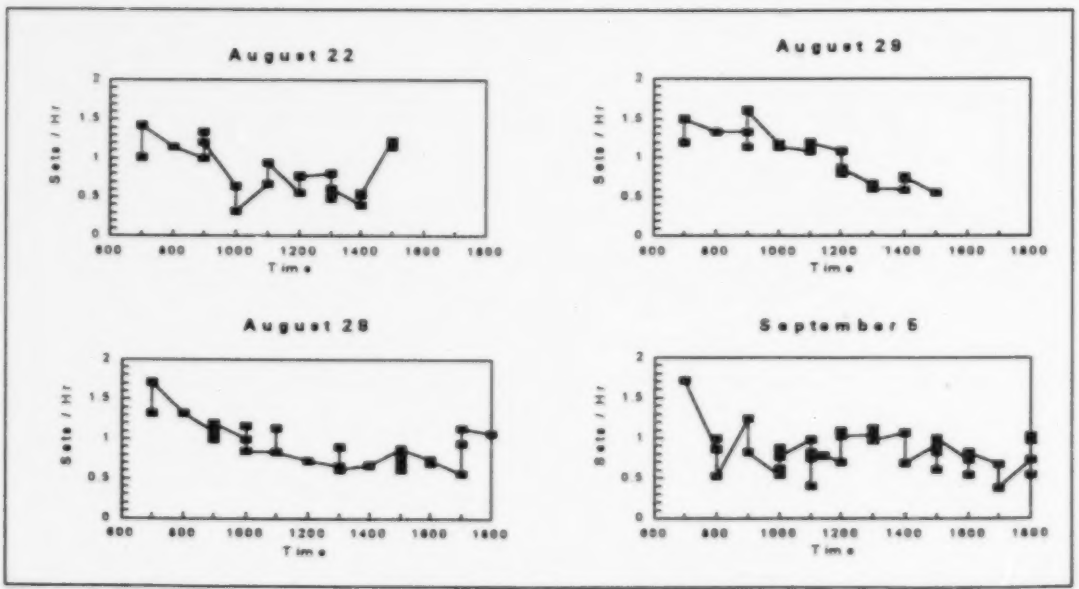

Figure 7. Relationship between the time of interview and the number of sets, Area 20 seine fishery, 1995.

In 1995, there were two weeks when two consecutive 12-hour fisheries occurred in Area 20. These were on August 28 and 29, and on September 5 and 6. Figure 8 compares the expansion and consecutive day methods for estimating the number of sets/day. It appears that the plots based on the consecutive methodology do not have a time basis as the expansion methodology does. As a result of this analysis, the total day's sample from the consecutive day methodology (when available) was used to estimate the average number of sets/day. When the consecutive day sampling was not available, the samples collected from 1400 hours to the end of the sampling day were used to estimate the average number of sets/day (Table 12).

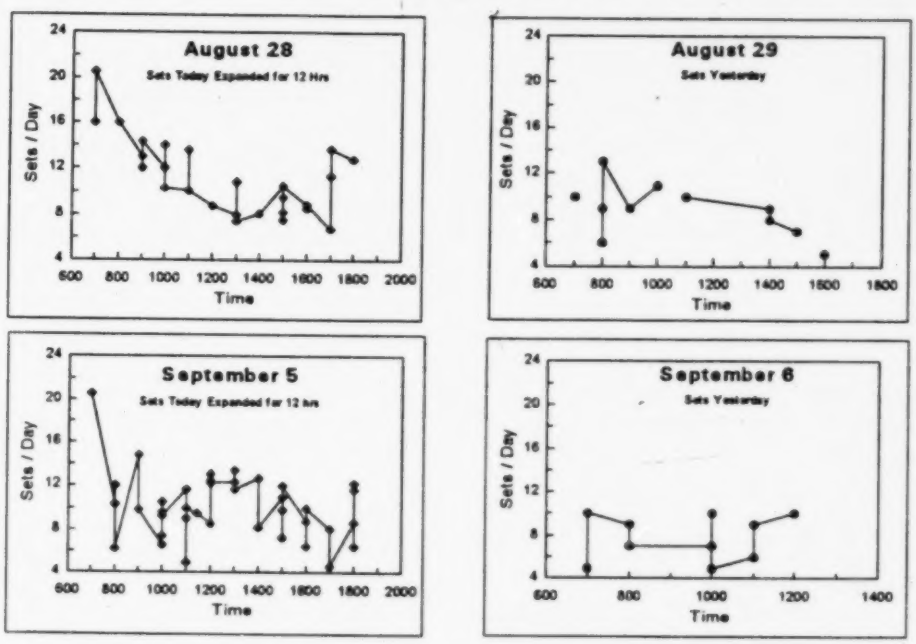

Figure 8. Comparison between the expansion and consecutive day methods for estimating the number of sets/day in Area 20 seine fishery, 1995.

Table 12. Comparison of the average number of sets/hour expanded to 12 hours vs. total number of sets the previous day during a 2-day fishery. Highlighted numbers are the values of sets/day used in the Monte Carlo simulations.

DATE	TIME	SETS/DAY	SETS YESTERDAY
Aug 22	0600-1000	12.6	
	1000-1400	8.4	
	1400-1800	9.2	
	0600-1800	10.3	
Aug 28	0600-1000	14.1	
	1000-1400	9.4	
	1400-1800	9.6	
	0600-1800	11.1	
Aug 29	0600-1000	14.7	7.0
	1000-1400	8.7	10.3
	1400-1800	7.8	8.5
	0600-1800	12.2	8.6
Sep 5	0600-1000	10.7	
	1000-1400	10.8	
	1400-1800	9.2	
	0600-1800	10.1	
Sep 6	0600-1000	7.8	8.0
	1000-1400	6.4	7.7
	1400-1800	Closed	Closed
	0600-1400	6.8	7.8

In 1995, there were two weeks when two consecutive 12-hour fisheries occurred in Area 20. These were on August 28 and 29, and on September 5 and 6. Figure 8 compares the expansion and consecutive day methods for estimating the number of sets/day. It appears that the plots based on the consecutive methodology do not have a time basis as the expansion methodology does. As a result of this analysis, the total day's sample from the consecutive day methodology (when available) was used to estimate the average number of sets/day. When the consecutive day sampling was not available, the samples collected from 1400 hours to the end of the sampling day were used to estimate the average number of sets/day (Table 12).

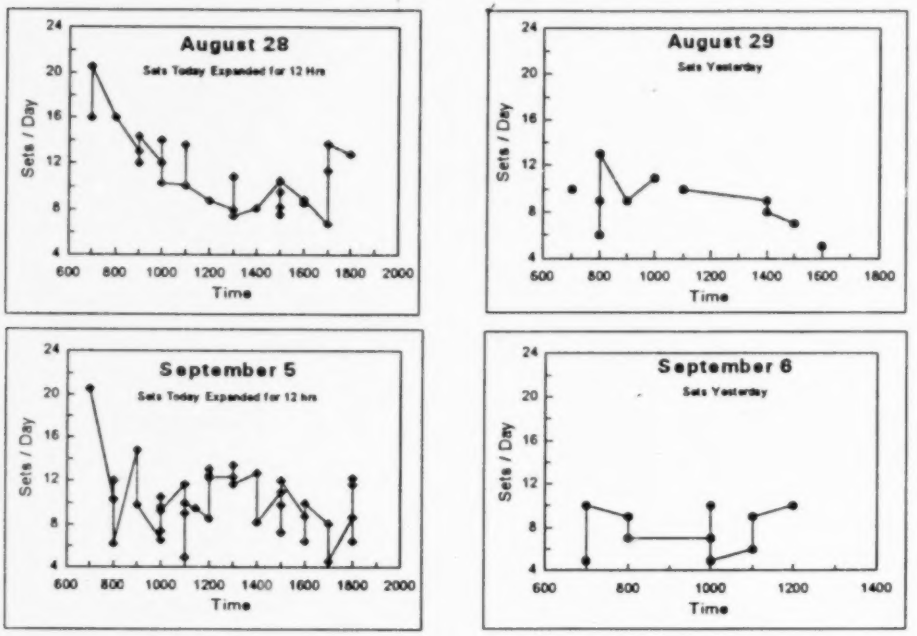

Figure 8. Comparison between the expansion and consecutive day methods for estimating the number of sets/day in Area 20 seine fishery, 1995.

Table 12. Comparison of the average number of sets/hour expanded to 12 hours vs. total number of sets the previous day during a 2-day fishery. Highlighted numbers are the values of sets/day used in the Monte Carlo simulations.

DATE	TIME	SETS/DAY	SETS YESTERDAY
Aug 22	0600-1000	12.6	
	1000-1400	8.4	
	1400-1800	9.2	
	0600-1800	10.3	
Aug 28	0600-1000	14.1	
	1000-1400	9.4	
	1400-1800	9.6	
	0600-1800	11.1	
Aug 29	0600-1000	14.7	7.0
	1000-1400	8.7	10.3
	1400-1800	7.8	8.5
	0600-1800	12.2	8.6
Sep 5	0600-1000	10.7	
	1000-1400	10.8	
	1400-1800	9.2	
	0600-1800	10.1	
Sep 6	0600-1000	7.8	8.0
	1000-1400	6.4	7.7
	1400-1800	Closed	Closed
	0600-1400	6.8	7.6

In the 1995 observer program, an estimated 21,832 coho were caught and retained (an additional 23,066 were caught and released, Table 13). The above observer estimate of retained coho was less than the sales slip estimate of 31,061 coho by 29.7% (Table 13). This underestimate of the observed coho catch in the monitoring program could be due to increased release of coho when the observers were present onboard the vessel. The observer program estimated an adult chinook catch of 629 compared to the sales slip estimate of 528 adult chinook. Similarly the chinook jack catch of 378 estimated in the observer program agreed closely with the sales slip figure of 381. During the 1995 observer program, 6 steelhead trout were observed caught and released. Using the catch algorithm outlined in the methods, this expands to a total released catch of 239 (range 208 - 280, 80% C.L. The observer program did not detect any steelhead being retained; however, the sales slip database showed 8 steelhead landed in the 1995 Area 20 seine fishery.

Table 13. Comparison of sales slip catch and Monte Carlo estimates for 1995.

	CHINOOK ADULT		CHINOOK JACK		COHO		SOCKEYE	PINK	STEELHEAD
	Retained	Released	Retained	Released	Retained	Released			Released
Sale Slip	528	NA	381	NA	31,061	NA	60,941	795,981	NA
Average	1,036	1,973	624	811	26,128	27,086	82,767	593,292	242
Median	629	1,581	378	533	21,832	23,066	70,473	516,589	239
80% C.L.	207 - 2,158	724 - 3,571	129 - 1,257	188 - 1,675	12,063 - 43,829	11,922 - 46,025	39,508 - 135,692	334,778 - 892,222	208 - 280

Week	CHINOOK ADULT			CHINOOK JACK			COHO		
	Sales Slip	Monte Carlo (median)	Monte Carlo (Avg)	Sales Slip	Monte Carlo (median)	Monte Carlo (Avg)	Sales Slip	Monte Carlo (median)	Monte Carlo (Avg)
8/3	244	74	244	156	49	154	2,629	420	820
8/4	208	300	712	156	204	422	11,966	3,110	5,098
9/1	76	22	81	69	13	50	16,466	14,054	20,209
Total	528	396	1,037	381	266	626	31,061	17,584	26,127

For the targeted species, the observer catch estimate for sockeye was 70,473 which was similar to the sales slip estimate of 60,941. In contrast, the observer catch estimate for pink salmon was 516,589 compared with the sale slip estimate of 795,981 pinks, a 35% difference. This may be due to a decrease in the observer's counting accuracy at high volumes of fish.

5.0 DISCUSSION

5.1 Monitoring Program

The monitoring program provided direct information on the catch in the Area 20 commercial seine fishery during 1994 and 1995. These observations can be expanded to provide total catch in the fishery, especially regarding the incidental catch. Such direct information is essential in order to estimate the amount of catch released in a non-retention type fishery. The timeliness of the catch information throughout the fishery was a major advantage of the observer program, allowing for a timely management response if coho catch rates increased above the desired level. The management response included time and/or area modifications to the fishery.

The observer data should be viewed with caution when extrapolating catches where few observations or incidents of catch by species have occurred. Other deficiencies in the data collection may include limited observer coverage when fish are being stowed, change in fishing pattern when the observer is onboard the vessel, and the inability by the observer to inspect and record all fish species caught and released. The inability of observers to quickly identify

species was also a problem, which was reported early in the season. Coho are probably more difficult to distinguish among other species because their size is similar to that of sockeye and the appearance is less conspicuous than that of other species (e.g., steelhead or chinook).

The difference in catch estimated in the monitoring program compared to catches recorded through sales slips, may not be attributed entirely to the monitoring procedure. Sales slip records do not always capture the "actual catch" in the fishery. For example, fish - especially those of low commercial value, are frequently not sold but rather kept for personal use. The magnitude of such unreported catch is not known for this fishery and could account for some of the catch difference.

The monitoring program was generally widely accepted by the commercial seine fishermen in Area 20; assistance and cooperation by skippers and crew members is necessary for this type of program to succeed. An understanding by crew members of the general procedures for successful release of fish would improve the program.

The volunteer portion of the monitoring program appeared quite successful. The volunteers were generally satisfied at efforts made or steps taken by DFO in consultation with fishermen to ensure the fishery minimized the catch of non-target species.

5.2 Management Strategy

The yellow line - red line strategy is one approach for regulating targeted ceiling-type fisheries. However, several problems may arise when using this approach to regulate by-catch in a fishery. One problem is that the by-catch species determines the fate of the fishery, and this may not be consistent with the target species objective. One solution is to evolve a series of actions which will reduce the by-catch yet continue to allow the catch of target species. The series of regulatory actions will increase in severity as the by-catch rate increases, while still allowing some harvesting of the target species.

Non-retention by the purse seine fleet is one action which would reduce by-catch, yet allow for limited target species harvest. Whether the non-retention measure is voluntary or mandatory, there needs to be some estimate of the total capture (retained and released) in order to estimate the overall mortality effect. As mentioned above, a monitoring program will deliver the necessary information required to obtain this estimate.

Other management actions include area and time closures. Reviewing in-season catch information, test fisheries and historical catch in relation to area and time, may provide opportunities to reduce the overall harvest of incidental species. This information could help decide whether to delay or close a fishery because of projected higher than desired by-catches during a specific time and/or area. This approach may be desirable where other actions during some types of fisheries are ineffective or difficult to implement.

All management actions require some type of incentive to become effective. This incentive is usually regulatory (enforcement) or economic (increased catch). A clear understanding of any management strategy and the reasons for its implementation is vital in soliciting maximum cooperation from all groups involved. Pre-season meetings conducted with seine fishermen from groups, such as the FVOA and UFAW, are essential for the success of these programs.

6.0 RECOMMENDATIONS

Monitoring Program Design

Planning of future monitoring programs is essential. The collaboration with fishing advisors, monitoring personnel and other agencies is crucial to the program delivery. An educational program assisting fishermen (especially crew members) on fish release techniques, species identification, and catch handling methods would be beneficial. Sample design should be reviewed, with the possibility of sampling the zones randomly and increasing the sample size in a particular fishing area. The objective may be to concentrate on specific areas to increase the existing database. The monitoring program should explore the possibility of a concurrent log book program to supplement catch information obtained from the monitoring program. It is important that monitoring staff be trained in obtaining the required information, such as identifying salmon species, standardizing vessel location and categorizing chinook salmon (juvenile, jack, adult).

Management Strategy

Additional actions for minimizing by-catch mortality may include the introduction of a "blue box" strategy which allows monitoring the fish incidentally caught prior to their release. Many commercial fishermen have this equipment and are using it in some commercial salmon fisheries. Other options to reduce incidental mortality also need to be explored. These options could include daylight only gillnet fisheries, brail only purse seine fisheries and gear modification (such as fish sorting equipment). The release fishery should concentrate on steelhead and chinook because of conservation concerns. The main objective of the Area 20 fishery is to target on returning Fraser sockeye and pink salmon, with minimal, yet recognized harvest of coho. An approach to this goal would be to establish a coho to target-species catch ratio; when this ratio is exceeded, a single or series of management strategies to reduce the ratio could be implemented. The Area 20 net fishery is only one component in the overall management of salmon populations. All other components need to be addressed to ensure all salmon goals are achieved. An enforcement program should complement the management strategy to assist in achieving program goals. All actions should be developed/carried out in consultation with the on-grounds advisors to promote the understanding and appreciation for the management goals and allow the fishers' input into the proposed actions.

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